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Article

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Article

Agro-Investments among Small Farm Business Entrepreneurs in the Era of the Fourth Industrial Revolution: A Case in the Mpumalanga Province, South Africa

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Abstract: Agro-investment in the fourth industrial revolution will be an imperative driving factor and a sacrosanct enabler for small farm business entrepreneurs to participate holistically in the agricultural economic value chain. Investing in advanced technology and entrepreneurship has the potential to promote business modernization and improve the productivity and profitability of farm businesses. This study assessed agro-investments in small farm business entrepreneurs in the era of the fourth industrial revolution in Mpumalanga province, South Africa. The study objectives were precisely to determine the perception of small farm business entrepreneurs on agro-investment and examine the impact of agro-investment for small farm business entrepreneurs in the fourth industrial revolution. The questionnaire used in this study employed structured and semi-structured questions for data collection, and an aggregate of 235 participants were randomly selected. The results on perception indicate that small farm business entrepreneurs mostly perceive agro-investment in the fourth industrial revolution as not suitable for small farm business conditions; this may be attributed to modern agricultural implements being predominantly manufactured in accordance with commercial sector specifications. The results from the binary logistic regression analysis on the perception of small farm business entrepreneurs in the fourth industrial revolution revealed that gender (P -value = 0.031), level of education (P -value = 0.04), farm size (P -value = 0.048), farming skills and knowledge (P -value = 0.027), farm productivity (P -value = 0.059) and investment opportunities (P -value = 0.057) were significant and influence the perception of small farm business entrepreneurs. The mean and standard deviation were used to assess the degree of severity of impact. From the results, sources of investment, technology, market participation, economic benefits, and government interventions were discovered to be impactful on agro-investment for small farm business entrepreneurs. The key contributions of agro-investments among small farm business entrepreneurs in the technological era embody catalyzed rural development, a diversified inclusive rural economy, and competitive participation in the agricultural food value chain. Another crucial contribution of the study is unlocking and accentuating the potential and opportunities that investors, technology designers, and manufacturers can exploit in small farm business agro-investments. This paper identifies and recommends that the South African government ought to create enabling environments for agricultural investment activities to thrive, especially among small farm business entrepreneurs, thereby providing grant funding and training, and enabling public-private stakeholder linkages.



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Keywords: investment; entrepreneurship; fourth industrial revolution; farm business; technology

1. Introduction

Agro-investment for small farm business entrepreneurs remains a fundamental driving imperative for the development of the agricultural sector, especially in the era of the fourth industrial revolution. As outlined in the National Development Plan (NDP) of

2030, investment in rural agriculture and the sector in its entirety has enabling prospects for economic growth, which is significant for the trajectory of poverty alleviation, food security, and job creation (Mtombeni et al. 2019). Theoretical and empirical evidence identifies the lack of capital investment, inadequate policy and legislation, market red tape, lack of business support from government and stakeholders, and low expertise as the main key production hindering factors for small farm business entrepreneur development (Hadebe 2016). The small farm business is regarded as a farming enterprise that is reliant on traditional farming systems, operates on small plots of land, and has limited access to credit, markets, and assets (DARDLEA 2020).

According to Herrington and Kew (2013), in terms of the global entrepreneurship monitor (GEM), South Africa is one of the lowest performing countries in the world as it relates to entrepreneurship due to factors such as low support mechanisms, high transaction costs, poor access to credit, and poor business development agencies. The innovation and the technologically driven era of the fourth industrial require high capital injection and investment in agriculture as it is characterized by satellites, in-field tech sensors, drones, and phone browser applications for agricultural business management through crop and livestock monitoring, ensuring water use efficiency, and soil requirements needs (EIP-Agri 2017).

Small farm business entrepreneurs are an integral pillar of economic development, job creation, and a source of food security and livelihood for the indigent (Manasoe et al. 2023). The current state of small business entrepreneurship in South Africa is below par when compared to other countries (Luiz and Mariotti 2011). Entrepreneurship in South Africa has not performed at a desirable level to address the multitude of socio-economic conundrums (Mamabolo et al. 2017). Despite the potential and prowess of small farm business entrepreneurs (Magadla 2023), the lack of access to investment, markets, resources, and modern technology infrastructure remains a hindrance (Ogujiuba 2021).

The fourth industrial revolution dictates agricultural investments in small farm businesses as an important aspect of sustainable development and economic growth. Schwab (2016) describes the fourth industrial revolution as a phenomenon that is characterized by the rapid emergence of advanced technologies that seek to amalgamate the digital, physical, and biological worlds. Central among the key drivers of the fourth industrial revolution include the Internet of Things, robotics, information and communication technology, nanotechnology, unmanned aerial vehicles, and artificial intelligence.

Investment of capital has been a fundamental aspect of entrepreneurship dating back to the first industrial revolution that was driven by the invention of steam, coal, and water-powered engines, which improved production between 1750 and 1840 (Easton et al. 2014), whereas the second industrial revolution propelled and enhanced mass production to the fore through the emergence of electricity between 1870 and 1904 (Atkeson and Kehoe 2001). The third industrial revolution mainly comprised the emergence of the internet, information technology, and electronics. Agro-investments in the first industrial revolution resulted in mechanization and rapid production of farm implements such as harvesting, drilling, threshing, and reaping machines (Allen 2009), while the second industrial revolution enabled improved agricultural productivity using chemicals to produce fertilizer, pesticides, and herbicides (Persson 2010). According to McKenzie (2007), the third industrial revolution in agriculture gave rise to synthesized seeds and cultivar varieties through the concept of the green revolution that was meant to minimize world hunger.

For small farm business entrepreneurs to thrive in the fourth industrial revolution, capital investment is a driving factor and is a paramount enabler for basic minimal participation in the agricultural value chain from the primary to the tertiary phase. According to Loftas and FAO (2021), investment is an apex and integral pillar for improved production output and economic growth in the medium and long term. Investments in agricultural entrepreneurship also influence the rate at which the business can modernize, increase production, utilize advanced and technical innovations, be ecologically friendly, and acclimatize to technological developments (Chen et al. 2014). Swinnen (2018) asserts that the

fundamental objective of investments in agricultural technology and innovation in farm business entrepreneurship should also be to explore all potential possibilities and create conducive conditions for the usefulness and application of these technologies to enhance productivity and economic prospects.

Moreover, [Stukan \(2020\)](#) posits that agro-investments play a significant role in the production value chain that ensures food security and sector stability. [Yusupjonovich \(2019\)](#) postulates that the relationship between investment and innovation in the agricultural setup centers around social and environmental security, consistency, and purposefulness. [Bastiaens \(2016\)](#) ultimately creates space for market participation and competing leverage.

Investment in agricultural production ought to be guided and directed in accordance with key aimed driving factors ([Levchuk 2015](#)). As a result, Figure 1 illustrates the five key factors and areas that ought to drive agro-investments in the fourth industrial revolution. These five key factors and areas include but are not limited to investment in farm business equipment and implements, investment in new fourth industrial revolution technologies, investment in policy, research, and development, investment in land expansion and acquisition, and investment in market access and participation.

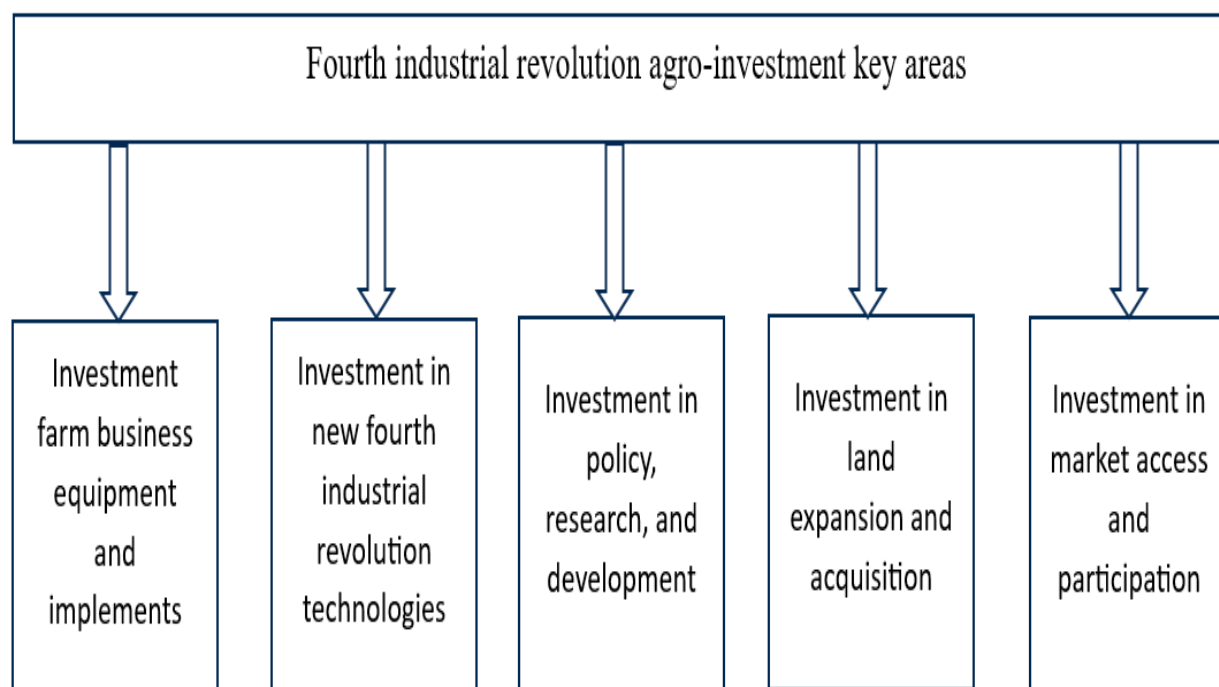


Figure 1. Fourth industrial revolution agro-investment key areas (Source: Author's Concept).

This empirical study assesses agro-investments in small farm business entrepreneurs in the era of the Fourth Industrial Revolution: A case of Mpumalanga Province, South Africa as a case study. The main research question is how agro-investment among small farm business entrepreneurs can enhance productivity in the fourth industrial revolution. The aim of the study was realized through two research questions: what is the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution, and what is the impact of agro-investment for small farm business entrepreneurs in the fourth industrial revolution? Specifically, the objectives of the study were to determine the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution and examine the impact of agro-investment for small farm business entrepreneurs in the fourth industrial revolution. The justification for the study is premised on inclusive development that promotes food security and poverty alleviation ([World Bank 2019](#)). Moreover, the study was undertaken due to its economic significance, as small farmers are responsible for producing over 80% of food in Sub-Saharan Africa.

Thus, agro-investment is crucial for productivity and economic growth (FAO 2018). In addition, the rapid technological advances of the fourth industrial revolution have the potential to improve the farming conditions of small farmers.

According to Agyekumhene et al. (2018), the fourth industrial revolution is viewed as a viable solution to address socio-economic issues and the development of small farmers. The study by Xie et al. (2021) on how smallholder farmers are involved in digital agriculture in developing countries in a case study from China found that digital transformation is an integral component of small farmers' empowerment in developing countries. Therefore, through expanding on existing knowledge and research, the paper attempts to find solutions for agro-investment in the fourth industrial revolution as it relates to small farm business entrepreneurs with a view that no farmers should be left out as development, evolution of systems, and transformation occur timeously.

A study about the application of technologies such as the internet of things (IoT) among small farmers in Nepal for the optimal growth of mushrooms indicates the real context in which the fourth industrial revolution technologies can be applicable (Lamsal et al. 2023). Additionally, a study by Furuholt and Matotay (2011) on the developmental contribution of mobile phones across the agricultural value chain in rural Africa discovered that smart mobile phones boosted the profits of farmers by 15% in Tanzania.

2. Literature Review

2.1. Agro-Investment Overview in South Africa

The agricultural sector plummeted by 12.3% in the first quarter of 2023, contributing only 0.4% to the overall gross domestic product (GDP), mainly due to low economic activities in the plant and animal production value chain (Stats SA 2023). The South African agricultural sector is dualistic, comprising the formal commercial and informal emerging farmers sectors (Vink and Kirsten 2003). Investments are skewed in favor of commercial farm businesses to the disadvantage of small farm business entrepreneurs who are mainly resource-poor and underdeveloped (Gwebu and Matthews 2018). Investment and access to credit remain a persisting challenge for small business entrepreneurs in South Africa (Ogujiuba et al. 2021). Investment is a mechanism used to increase the economic production capacity by committing to utilizing current available financial resources for expansion and overtime returns. Consequently, investment in agriculture through research, human capital, and infrastructure is crucial in promoting sustainable development and economic growth. Scholarly research with empirical evidence indicates that household socioeconomic characteristics, institutional factors, and product content, whether in formal or informal agriculture, influence investments (Baiyegunhi and Fraser 2014).

2.2. Agro-Investment Outlook in the Fourth Industrial Revolution

The transformation of the agricultural sector from animal and human-powered implements in the first industrial revolution to the manufacturing of herbicides, pesticides, and fertilizers in the second industrial revolution, and all the way to the green revolution era of synthesized seeds in the third industrial revolution (Nkosi 2022), has always been propelled and advanced through investments and entrepreneurship at the center of development. Likewise, agriculture in the fourth industrial revolution is bound to be driven by investments, particularly towards small farm business entrepreneurs.

Agro-investment in the fourth industrial revolution will result in precisely optimized farming, efficient and effective use of natural resources, and a positive impact on climate change and weather-related issues (Lee 2017). Agriculture in the fourth industrial revolution is characterized by manufacturers, developers, and entrepreneurs who focus on crop efficiency technology, reforming the agricultural value chain, bioenergy, vertical farming, bio-chemicals, and food technology. Investments in agriculture, particularly among small farm business entrepreneurs, remain bleak; this is due to inadequate access to financial resources that enable technology adoption (Koo 2014).

2.3. Farm Business Entrepreneurship

South Africa, as a developing country, has one of the lowest entrepreneurship development and activity rates when compared at a global scale (Foxcroft et al. 2002), with low literacy levels, inadequate access to financial resources, social and entrepreneurial factors that do not prioritize the development of entrepreneurial business skills as a crucial path to be followed (Herrington et al. 2009). Various studies that have been undertaken on business entrepreneurship present reluctance toward the recognition of farmers as entrepreneurs (Hadebe 2016); hence, the definition of farmer entrepreneurship remains abstract. According to Juma and Spielman (2014), the reluctance to recognize farmers as entrepreneurs emanates from the perspective that farmers are notably and generally considered as primary producers rather than business personnel. Often, farmers are viewed as individuals who operate outside formal markets and do not align with a contemporary description of an entrepreneur (Bauernschuster et al. 2010). Shane and Venkataraman (2000) posit that the lack of a common definition of entrepreneurship, particularly in farming, restrains the sector from developing. Ahmad and Seymour (2008) contradict the notion of not considering farmers as entrepreneurs by defining entrepreneurship as an endeavor that seeks to explore and exploit economic activity gaps based on producing products that are in demand and have market access in pursuit of generating value. These assertions are supported by Hisrich et al. (2013), who argued that entrepreneurship is based on taking financial and social risks and investing time and effort to advance socio-economic interests through revenue generation. Ghiasy and Hosseini (2012) assert that entrepreneurship is regarded as a catalyst for entrepreneurial growth and development. The importance of farm business entrepreneurship is premised on the fundamental perspective of considering natural resources, biodiversity, and ecosystems while advancing the primary goal of ensuring food security and sustainable agriculture (Suman et al. 2014).

2.4. Investment in Agricultural Farm Business Entrepreneurship in the Fourth Industrial Revolution

Investment remains an integral pillar of entrepreneurship. As a technology-driven era, the fourth industrial revolution is different from the first three industrial revolutions (Dombrowski and Wagner 2014) due to its high level of innovation and digitalization. WEF (2018a, 2018b) indicates that technologies of the fourth industrial revolution will ignite the digitization of over 60% of global economies, including Sub-Saharan countries. According to Nkosi (2022), investment in advanced technology, education and training, innovation, and policy and research are critical aspects of enabling development in farm business ventures within the agricultural sector. Investment in advanced technology entails the injecting of capital by the government, funding agencies, and the private sector in telecommunications, the Internet of Things, drones, robotics, artificial intelligence, cloud computer systems, nanotechnology, and three-dimensional printing (Lom et al. 2016). This form of investment will prompt an improved performance in the production and performance of crops and livestock and reduce intensive labor input costs while promoting precision agriculture as a means to balance environmental and economic imperatives (EIP-Agri 2017). Education and training are other important attributes as the fourth industrial revolution demands an adept, highly skilled, and technical labor force (Manda and Dhaou 2019). A shift from a labor-intensive orientation to a much more technical orientation that is characterized by individuals who are technologically inclined and shrewd is expected in the fourth industrial revolution (Manda and Backhouse 2016). Thus, farm business entrepreneurs need to be appropriately empowered with the relevant skills to acclimatize and thrive. A skills revolution to capacitate and educate remains fundamental to complement and manage technology at a remodeling, operation, and maintenance level (WEF 2016). Manda and Dhaou (2019) postulated that innovation based on production methods and business models drives the fourth industrial revolution, and as such, investment in research and development is sacrosanct. South Africa ought to improve its innovative capacity in relation to technology-based research and development to be able to compete at a global

scale (McKinsey Global Institute 2015). Investment in policy and research for farm business entrepreneurship is important; according to the European Commission (2015), the fourth industrial revolution should be driven by policies and legislation that prioritize funding, skills, and infrastructure. Policy certainty creates an environment that is conducive to domestic and international trade. It is always advisable for governments to review and improve policy positions pertaining to technology to develop and institute concrete strategies to deal with the challenges and opportunities of the fourth industrial revolution (Fan et al. 2014).

2.5. Conceptual Framework

Figure 2 illustrates how agro-investment in the fourth industrial revolution influenced small farm business entrepreneurs. Glover et al. (2019) stated that advanced and modern technology is regarded as intrinsic and necessary to build capable and resilient small business entrepreneurial systems that promote agricultural production and sustainability. This conceptual framework is adapted and modified from the Gnyawali and Fogel integrative model of entrepreneurial environment, the Lado and Vozikis transfer of technology model, the technology acceptance model of Davies, and the Kalecki model of investment in agricultural business.

According to Gnyawali and Fogel (1994), the integrative model of entrepreneurship is based on creating a conducive platform for entrepreneurship development and for a business to thrive. It identifies five dimensions that are instrumental in the likelihood of individuals undertaking business ventures. The first dimension is government policies and procedures, which are the main focus of denouncing the censorship and bottlenecks that prohibit market participation by removing red tape and administrative barriers. The second dimension centers around socio-economic conditions that promote entrepreneurship participation and support. The third dimension expands on entrepreneurial and business skills that promulgates education and training services in technical skills to build internal capacity for emerging market economies. The fourth dimension is the critical aspect of financial investment to promote growth and expansion. The last dimension deals with non-financial support to businesses through the creation of environments for entrepreneurs to undergo and attain business incubation, communication skills, marketing knowledge, networking, and government procurement programs.

The transfer of technology to promote entrepreneurship identifies technological content and context, technology transfer mode, and the economic level of a country as important attributes for entrepreneurship development (Lado and Vozikis 1996). As the fourth industrial revolution is driven by advanced technological innovations, Davies et al. (1989) asserted that the technology acceptance model becomes central to measuring whether an individual accepts technology not based on perceived usefulness and perceived ease of use. Lastly, to conceptualize the investment aspect of the topic, the Kalecki model of investment in agricultural business. According to Grzelak and Kułyk (2020), the Kalecki model of investment in agricultural business views investment as a binary concept that is based on demand and supply. In the context of the present study, this means that to enable agricultural investment in the fourth industrial revolution for small farm business entrepreneurs to thrive, government policies, education and training, financial and non-financial support, socio-economic conditions, perceived usefulness and ease of use, financial support and entrepreneurship development are of prime importance in this regard.

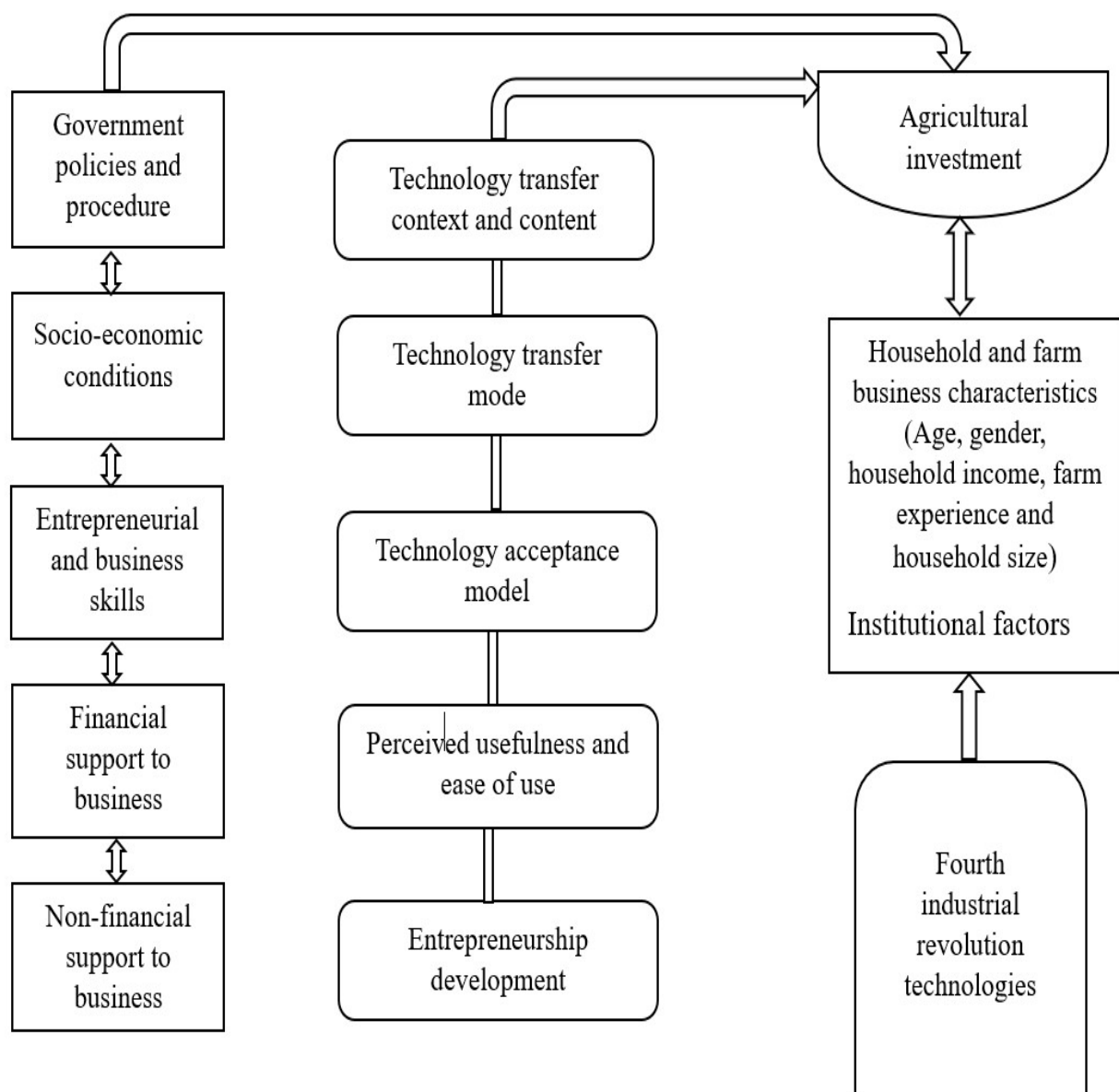


Figure 2. The conceptual framework of investment in small farm business entrepreneurs in the fourth industrial revolution (adapted from [Gnyawali and Fogel 1994](#); [Lado and Vozikis 1996](#); [Davies et al. 1989](#); [Kalecki 1935](#)).

3. Materials and Methods

3.1. Study Area

The study was conducted in Breyten and Lothair in wards 14 and 15, respectively, within the jurisdiction and demarcation of Msukaligwa local municipality, which is situated in the eastern central of Gert Sibande district municipality, Mpumalanga Province of South Africa (Figure 3). The research study areas are located within the latitudes $-26^{\circ}32'59.99''$ South and longitudes $29^{\circ}09'60.00''$ East in terms of their geographical location. Mpumalanga is the second smallest province occupying 76,495 square kilometers (6.3%) of the total land of the country. However, Mpumalanga is a large region for agricultural activities in plant, animal, and mixed production. Gert Sibande district municipality is a Category C municipality and the largest of the three district municipalities in Mpumalanga, spanning over 31,840 square kilometers of the land with seven local municipalities, namely Msukaligwa, Chief Albert Luthuli, Dipaliseng, Mkhondo, Govan Mbeki, Lekwa and Dr Pixley ka Isaka Seme. Msukaligwa local municipality is predominantly

rural, covers a total area of 6016 square kilometers with a total population of 199,314 people, with Breyten and Lothair having 14,347 and 6099 people respectively ([Statistics South Africa Census 2022](#)). According to the [Mpumalanga Department of Finance \(2015\)](#), the most productive economic and highly contributing sectors towards the gross domestic product (GDP) in Gert Sibande district and Msukaligwa in particular include but are not limited to agriculture, mining, manufacturing, utilities, construction, trade transport, finance, and community services. The leading industries in terms of employment are trade, community services, and agriculture with 23.7%, 19%, and 11.5%, respectively). Agriculture is deemed as a crucial economic pillar within the Mpumalanga province. As a result, it is against this backdrop that Mpumalanga province, Gert Sibande district, and the Msukaligwa local municipality was preferred as the choice of location to undertake this study.

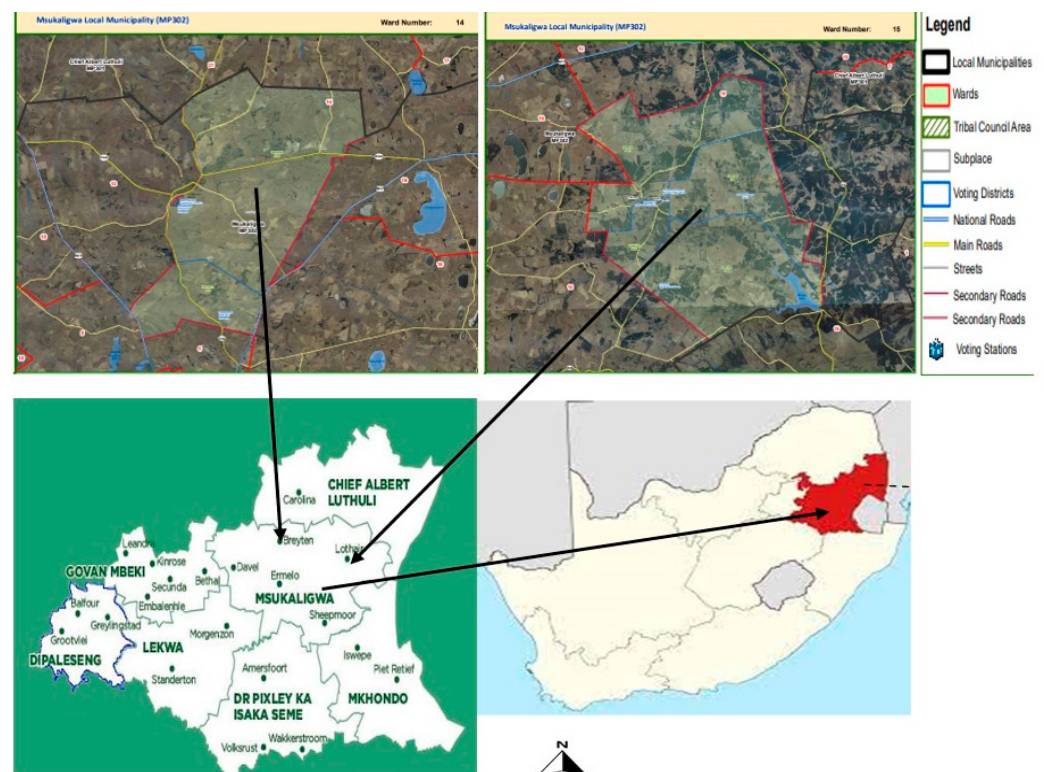


Figure 3. Location of Breyten and Lothair, within the Msukaligwa local municipality of Gert Sibande district municipality in Mpumalanga, South Africa (Source: Author's Concept from Google Maps and Municipal Demarcation Board).

3.2. Sampling Procedure and Sample Size

For this study, the quantitative research paradigm was adopted. The quantitative method quantifies variation and predicts relationships in a given population. The target population and selection of study areas employ a criterion of small farm business entrepreneurs found within the municipality demarcation, who are largely farming communities. Purposive sampling was employed in the process of selecting the two study areas. This sampling method empowers the researcher to select participants that are fit for purpose ([Campbell et al. 2020](#)). However, the study used the simple random sampling method, which is a probability sampling technique, to avoid and eliminate bias in relation to participation in the attainment of the study objectives ([Creswell 2014](#)). The unit of analysis for this study involved small farm business entrepreneurs who are actively involved in agricultural productive activities. There are 1034 small farm business entrepreneurs in Msukaligwa local municipality, with Breyten and Lothair having 195 and 187, respectively ([DARDLEA 2020](#)). A margin of error of 5% and a confidence interval of 95% were effectively

employed to determine the sample size of both study areas through the deployment of Slovin's formula.

$$\text{Slovin's formula: } n = N / (1 + Ne^2)$$

where: n —represents the sample size; N —Represents the population size; e —Represents the margin of error.

Consequently, in Table 1, a sample size of 131 in Breyten and 127 in Lothair was obtained, yielding a total sum of 258 small farm business entrepreneurs. However, due to budgetary and time constraints, only a sample size of 235 was realized.

Table 1. Summary of the sampling procedure.

Study Areas	Population	Slovin's Formula	Sample Size
Breyten	195	$n = N / (1 + Ne^2) = 195 / (1 + 195(0.05)^2)$	131
Lothair	187	$n = N / (1 + Ne^2) = 187 / (1 + 187(0.05)^2)$	127
Total			258

3.3. Data Collection

To elicit data for this study, both primary and secondary data were collected. The primary data was collected using a structured questionnaire developed as the survey instrument. Secondary data obtained from sources such as journals, books, and literature reviews were also utilized. In ensuring the comprehension of the survey questions among respondents, rigorous attention was given to the question design, which avoided the use of technical jargon and complex syntax prior to administering the questionnaire (Fowler 2017). Moreover, pilot testing and question-wording were done to further eliminate the potential for ambiguity (Dillman et al. 2014). A pre-test of the questionnaire with 20 selected small farm business entrepreneurs was conducted to validate the applicability and appropriateness of the questionnaire and to train the three enumerators who assisted the researcher in administering the questionnaire. The field survey that culminated in this work was carried out between April and August 2021. The questionnaire employed to collect field survey data was grouped into three sections, namely, socio-demographic characteristics, the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution, and the impact of agro-investment for small farm business entrepreneurs in the fourth industrial revolution.

3.4. Data Analysis

Quantitative data was analyzed using descriptive statistics such as frequency counts, percentages, means, and standard deviation, as well as the binary logistic regression method. The IBM Statistical Package for Social Sciences (SPSS) Version 27 was the main software that was used to carry out all these analyses.

3.5. Model Specification

The binary logistic regression analysis was adopted in this study as a model that is suitable and befitting in dichotomous dependent variables (Berger 2017). In this study, the equation below illustrates the factors that affect the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. This model was used to measure perception based on the classification of individuals into one or two populations subject to one set of known predictor variables. Table 2 outlines the summary of predictor variables. There are no assumptions made with respect to the distribution of the predictor variables (X); however, X variables may be discrete or continuous (Afifi et al. 2004). Mercer et al. (2005), Afifi et al. (2004), and Salam et al. (2000) let R_i represent a dichotomous variable that would be equal to 1 if small farm business entrepreneurs perceive agro-investment in the fourth industrial revolution as a challenge and 0 if they do not. The model is suitable to measure perception as it was used effectively in studies by Oguz and Assefa (2014) on Faculty members' perceptions towards institutional repository

at a medium-sized University, an application of a binary logistic regression model, and [Rai et al. \(2023\)](#) on the analysis of farmers' perceptions of climate change and Adaptation Strategies in the Transboundary Gandaki River Basin. The probability of perceiving a challenge, $Pr(R_i = 1)$, or not, $Pr(R_i = 0)$, is derived as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_{11} X_{11} + \mu$$

where:

Y = Perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution = 1, 0 = otherwise)

X_1 – X_{13} = Independent variables defined as:

X_1 = Age (years)

X_2 = Gender (Male = 1, Female = 2)

X_3 = Education level (No school = 1, ABET/Adult education = 2, Primary = 3, Secondary = 4, Tertiary = 5)

X_4 = Household size (<5 people = 1, 5 to 10 people = 2, >10 people = 3)

X_5 = Monthly income (<R1000 = 1, R1001 to R3000 = 2, R3001 to R5000 = 3, >R5000 = 4)

X_6 = Source of income (Salary/wage = 1, Pension = 2, Grants = 3, Remittance = 4, Other = 5)

X_7 = Farm size (<Acre = 1, One acre = 2, Two acres = 3, >Two acres = 4)

X_8 = Farming experience (<5 years = 1, 5 to 10 years = 2, >10 years = 3)

X_9 = Farming skills and knowledge (Plant production = 1, Animal production = 2, Both animal and plant production = 3)

X_{10} = Time invested on field ($\leq$ One hour = 1, Two to five hours = 2, >Five hours = 3)

X_{11} = Farm productivity (Yes = 1, No = 2)

X_{12} = Investment opportunities (Improve production = 1, Reduce farm labor = 2, Improve quality of produce = 3, Controlled farming environment = 4, Reduce use of herbicides and pesticides = 5, Longer production season = 6, Other = 7)

X_{13} = Investment constraints (Not suitable for small farm entrepreneurs = 1, Requires prior learning = 2, Inadequate access to markets = 3, Lack of collateral = 4, High interest rates = 5, Low production outputs = 6, Poor government support = 7, Limited investments = 8)

β_0 = constant

β_1 – β_9 = standardized partial regression coefficients

μ = error term

Table 2. Summary of predictor variables hypothesized with their operational description, measurement, and expected signs.

Variable and Code	Operational Description	Measurement Unit	Expected Sign
Age (AGE)	Lived number of years of a person	(18–35 years) = 1, (36–49 years) = 2, (50–60 years) = 3, ($\geq$ 61 years) = 4	–
Gender (GDR)	The natural state of being male or female	1 = Male, 2 = Female	–/+
Education level (EDUC)	Level of education obtained	Never been to school = 1, Abet/adult education = 2, Primary = 3, Secondary = 4, Tertiary = 5	+
Household size (HSIZ)	Number of people within a household	<5 people = 1, 5 to 10 people = 2, >10 people = 3	+
Monthly income (MONT)	Income per month	<R1000 = 1, R1001 to R3000 = 2, R3001 to R5000 = 3, >R5000 = 4	+

Table 2. Cont.

Variable and Code	Operational Description	Measurement Unit	Expected Sign
Source of income (SINC)	Various channels through which individuals earn money	Salary/wage = 1, Pension = 2, Grants = 3, Remittance = 4, Other = 5	+
Farm size (FSIZ)	Area cultivated in acres	<Acre = 1, One acre = 2, Two acres = 3, >Two acres = 4	+
Farming experience (FEXP)	Duration involved in farming	<5 years = 1, 5 to 10 years = 2, >10 years = 3	−/+
Farming skills and knowledge (FMSK)	Farming specialization	Plant = 1, Animal = 2, Both animal and plant = 3	−/+
Time invested in field	Active farming period in the field	≤One hour = 1, Two to five hours = 2, >Five hours = 3	−
Farm productivity (FPRO)	Enhancement of agricultural productivity	1 = Yes, 2 = No	+
Investment opportunity (INVOP)	Perceived opportunities	Improve production = 1, Reduce farm labor = 2, Improve quality of produce = 3, Controlled farming environment = 4, Reduce use of herbicides and pesticides = 5, Longer production season = 6, Other = 7	+
Investment constraints (INVCO)	Perceived problems	Not suitable for small farm entrepreneurs = 1, Requires prior learning = 2, Inadequate access to markets = 3, Lack of collateral = 4, High interest rates = 5, Low production outputs = 6, Poor government support = 7, Limited investments = 8	+

3.6. Measurement of the Impact Based on the Mean and Standard Deviation

The impact of agro-investment on small farm businesses was assessed using the mean and standard deviation to elucidate the degree of severity of the impact. Upholding the predetermined decision rule, a total mean value for impact was adopted as follows: 1–5 = Not severe, 6–10 = Less severe, 11–15 = Severe, 16–20 = Most severe.

3.7. Ethical Considerations

The study adhered to the ethical issues involved. An ethical clearance was obtained from the University of Mpumalanga, as approved by the Ethics Committee from the Faculty of Natural and Agricultural Sciences. Consent from participants was humbly solicited, and confidentiality was guaranteed. A consent form was signed by participants before the commencement of questions, and thus, the principle of anonymity and voluntary participation was adhered to and considered.

4. Results and Discussion

4.1. The Perception of Small Farm Business Entrepreneurs on Agro-Investment in the Fourth Industrial Revolution

The results from the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution are shown in Table 3. From the results, it can be deduced that 34.9% of the respondents perceive agro-investment in the fourth industrial revolution as not suitable for small farm business entrepreneurs. This may be attributed to modern agricultural implements being predominantly manufactured according to the specifications of the commercial sector, while 26.8% believe that it requires prior training, and 10.6 % indicate that the lack of collateral is a stumbling block. A further 9.4% of the respondents indicated a challenge of limited investments, whereas 8.9% cited inadequate access to markets as a factor influencing their perceptions. The remainder of the respondents indicated that high interest rates (4.7%), poor government support (3.0%), and low production output (1.7%) influenced

their perception of agro-investments. The limited small farming land size, which may not be suitable for large technological equipment (Masere 2015), has the likelihood of influencing the perception of agro-investment among farmers.

Table 3. Perception of small farm business on agro-investment in the fourth industrial revolution.

Variables	Frequency	%
Not suitable for small farm entrepreneurs	82	34.9
Requires prior learning	63	26.8
Inadequate access to markets	21	8.9
Lack of collateral	25	10.6
High interest rates	11	4.7
Low production output	4	1.7
Poor government support	7	3.0
Limited investments	22	9.4
Total	235	100.0

4.2. Determinants of Perception of Agro-Investment in Small Farm Business Entrepreneurs in the Fourth Industrial Revolution

Exploring and assessing the fitness of the model employed, the study obtained a 1.00 goodness-of-fit test as a means to verify the suitability and appropriateness of the parameter estimates. A Nagelkerke R^2 of 0.442 with a $-2\log$ likelihood of 212.971a was attained. A level of 0.321 for the Cox & Snell R^2 was recorded with an overall 80.0% correctly predicted percentage. This indicates that the variables computed adequately affirm the appropriateness of the model used in this study. Moreover, putting into service the 0.05 barometer of statistical significance, gender, education level, farm size, time invested in production, farm productivity, and investment constraints were found to be significant in relation to the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. The variables with significant influence are discussed below as informed by Table 4.

Table 4. Determinants of perception of agro-investment in small farm business entrepreneurs in the fourth industrial revolution.

Determinants of Perception Independent Variables	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Age	0.222	0.236	0.882	1	0.348	1.248	0.786	1.984
Gender	0.808 *	0.374	4.661	1	0.031	2.244	1.077	4.676
Education level	−0.640 *	0.225	8.099	1	0.004	0.527	0.339	0.819
Household size	−0.174	0.279	0.391	1	0.532	0.840	0.486	1.451
Monthly income	−0.030	0.270	0.012	1	0.911	0.970	0.572	1.647
Source of income	0.122	0.205	0.353	1	0.552	1.130	0.756	1.688
Farm size	−0.393 *	0.199	3.905	1	0.048	0.675	0.457	0.997
Farming experience	0.475	0.270	3.086	1	0.079	1.608	0.947	2.731
Farming skills and knowledge	0.688 *	0.311	4.884	1	0.027	1.989	1.081	3.662
Time invested on field	−0.168	0.264	0.404	1	0.525	0.846	0.504	1.419
Farm productivity	0.507 *	0.268	3.571	1	0.059	1.660	0.981	2.808
Investment opportunities	−0.238 *	0.125	3.631	1	0.057	0.788	0.617	1.007
Investment constraints	0.070	0.099	0.500	1	0.480	1.072	0.884	1.301
Constant	−0.435	1.763	0.061	1	0.805	0.647		
−2 Log likelihood	212.971a							
Nagelkerke R^2	0.442							
Cox & Snell R^2	0.321							
Percentage correctly predicted	80.0%							

* $p \leq 0.05$.

The findings reveal that gender with $P\text{-value} = 0.031$ with a coefficient of $\beta = 0.808$ was significant and positively influenced the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. These results contradict the findings by [Nkosi \(2022\)](#) in the study conducted on the fourth industrial revolution's opportunities and constraints, which found that gender was not significant in relation to innovation and technology. However, the findings of this study are congruous with the findings from a study conducted by [Agholor et al. \(2023\)](#) on the socio-demographic context of resilience for adaptation to climate change and implication for agricultural extension in Buffelspruit, South Africa, which discovered that women in farming perceive innovation and advanced agricultural developments as important than men. Consequently, a study by [Li et al. \(2008\)](#) found that gender is significant in relation to the perception of factors such as affordability, ease of use, and usefulness.

The findings on education level ($P\text{-value} = 0.04$, and the coefficient of $\beta = -0.640$) indicate a significant influence, however negatively related to the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. The implication of these findings is that as education level increases, there is a 0.339 decrease in the log odds of perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution, provided all other variables are kept constant. These findings contradict those by [Caswell et al. \(2001\)](#) and [Atsriku \(2020\)](#), who found that the higher the education level and aptitude of farmers, the higher the likelihood of comprehension and adaptability to modern technology than farmers with low education levels. There are scenarios based on certain factors wherein higher education levels can negatively influence perception; these include inter alia dependency on conventional farming systems, complexity of information, limited access to practical skills, high cost, and associated risks.

Farm size recorded a $P\text{-value} = 0.048$, and the coefficient of $\beta = -0.393$, which implies that the farm size is significant; however, it negatively influenced the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. This suggests that as farm size increases, the log odds of the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution, provided all other variables are kept constant, decreases by 0.457. These findings on farm size are negated by those in a study undertaken by [Agholor \(2014\)](#) on the analysis of decision-making in smallholder irrigation practice in Shiloh and Zanyokwe irrigation schemes in Central Eastern Cape, South Africa. University of Fort Hare, Alice. The findings were that a small farm size has production limitations stemming from the inability to invest in the use of mechanized farm machinery such as tractors and other implements than on a large farm size. The results of this study indicate that small farm business entrepreneurs are likely to perceive agro-investment as a challenge with an increase in farm size. Small farm business entrepreneurs tend to operate in varied socio-economic, environmental, and geographical contexts. Therefore, the location and characteristics of the farm, regardless of size, may influence the negative perception.

Farming skills and knowledge were significant with a $P\text{-value} = 0.027$ and a coefficient of $\beta = 0.688$, and positively related to the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. This implies that as farming skills and knowledge increase, the log odds of the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution, provided all other variables are kept constant, increases by 1.081. These results are in accord with the findings by the Organization for Economic Co-operation and Development ([OECD 2001](#)), which discovered that a high level of farm management and farmer skills are a prerequisite for most sustainable farming systems to operate.

Farm productivity was significant with a $P\text{-value} = 0.059$ and a coefficient of $\beta = 0.507$, and positively related to the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. The findings suggest that as farm productivity increases, there is a 0.981 increase in the log odds of the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution, provided all

other variables are kept constant. These results are in line with the findings of [FAO \(2001\)](#), which found that agricultural investment remains a sacrosanct factor in promoting and enhancing farm productivity and plays a fundamental role in promoting long-term growth. Similarly, [Becker \(1964\)](#) also made a similar conclusion that human capital investment is important as it increases the cognitive abilities of individuals through knowledge and skills attained from education and experience.

The findings on investment opportunities with a P -value = 0.057 and a coefficient of $\beta = -0.238$ indicate a significant influence that is negatively related to the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. The implication of these findings is that as investment opportunities increases the log odds of the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution, provided all other variables are kept constant, decreases by 0.617. These findings contradict the findings contained in the study on the analysis of investment opportunities available to small businesses and investment clubs in Gauteng province undertaken by [Tanzi \(2020\)](#), which found that the enthusiasm of small, medium, and micro enterprises on investment activities is influenced by the availability of opportunities. Inadequate and tangible farmer support for technology development substantiates the negative perception towards investments in the fourth industrial revolution.

Acknowledging all the notable constraints that engulf small farm business entrepreneurs adopting new technologies, the prospective benefits such as increased productivity, market competitiveness, and sustainability may entice these farmers. Through the right support from the government and relevant stakeholders, small farm business entrepreneurs can harness the prowess of new technologies to improve their livelihoods, contribute to food security, and promote rural development.

Small farm business entrepreneurs are severely confronted by constraints such as limited access to credit, lack of collateral, inadequate land size, and uncertainty in returns, therefore making it difficult to afford investments in new technological tools. Hence, the government has a much bigger role to play in assisting small farm business entrepreneurs to access funding through enabling policies, technical support, grants, and subsidized loans. From a South African government perspective, the National Development Plan of 2030 and the Agricultural Policy Action Plan seek to prioritize technology access and use among small farmers through the creation of funding channels to enhance productivity and food security ([DAFF 2015](#)).

4.3. Impact of Agro-Investment for Small Farm Business Entrepreneurs in the Fourth Industrial Revolution

Table 5 depicts the mean and standard deviation of the impact of agro-investment for small farm business entrepreneurs in the fourth industrial revolution by the respondents in the study. The findings on the sources of investment variables, which comprise government, own contributions, donations, private institutions, and banks, were classified as severe and summed up to $\bar{X} = 11.25$ and $\sigma = 3.60$. Most farm business entrepreneurs find it challenging to access investment to expand and improve their agricultural enterprises. According to the [FAO \(2013\)](#), small farm business entrepreneurs are the most important investors in their own farms ([Metzger and Adrew 2013](#)). Investment from private institutions remains below par and extremely low in agriculture, particularly in developing countries. The findings of this study are consistent with the study on investment and sources of investment finance in developing countries conducted by [Görg et al. \(2007\)](#), which found that market-friendly and business-enabling environments and government systems tend to promote high investments. [Metzger and Adrew \(2013\)](#) also found that sources of investment remain a difficult and complex task considering digitized financial institutions.

Table 5. Impact of agro-investment for small farm business entrepreneurs.

Impact (N = 235)	Mean ($\bar{X}$)	Std dev.
Sources of Investment		
Government	1.65	0.48
Own contributions	1.50	0.50
Donations	1.58	0.50
Private institutions	1.67	0.57
Banks	1.67	0.57
Total	1.53	0.50
Government	1.65	0.48
Total	11.25	3.60
Technology		
Unmanned aerial vehicles	1.33	0.51
Three-dimensional printing	2.00	0.00
Robotics	1.33	0.47
Nanotechnology	1.50	0.70
Artificial intelligence (AI)	1.60	0.50
Internet of things (IoT)	1.54	0.50
Other	1.61	0.48
Total	10.91	3.16
Market Participation		
Local Markets	1.50	0.50
Directly to Consumers	1.53	0.50
Retail Markets	1.51	0.50
Contract Markets	1.63	0.48
Agro-processing Markets	1.45	0.51
Total	7.62	2.49
Potential Economic Benefits		
Improve Profits	1.47	0.50
Create Employment Opportunities	1.63	0.48
Enable Credit Access	1.56	0.50
Enhance Productivity	1.53	0.50
Poverty Reduction	1.46	0.50
Total	7.65	2.48
Government interventions		
Policy Framework	1.50	0.50
Provision of Grant Funding	1.65	0.48
Provision of Training and Skills	1.44	0.50
Enabling Stakeholder Linkages	1.46	0.50
Addressing environmental issues	1.53	0.51
Total	7.58	2.49

In relation to the impact of technology, the related variables indicate results of $\bar{X} = 10.91$ and $\sigma = 3.16$. This shows the severity of agro-investment among small farm business entrepreneurs during the fourth industrial revolution. There is limited knowledge and understanding of technologies related to the fourth industrial revolution among small farm business entrepreneurs, which has a negative impact on agro-investment. [Otsuka and Larson \(2015\)](#) posit that agricultural workshops and training on advanced technology remain very effective tools in imparting knowledge to farmers on various technologies. Investing in agricultural technologies is fundamental to promoting agricultural development ([Goldstein and Udry 2008](#)). In a study by [Heeks \(2018\)](#), a discovery was made that the agricultural value chain, as it relates to technology, requires small farmers to be inculcated about new developments in technology investment to diminish skepticism.

The results pertaining to market participation summated to $\bar{X} = 7.62$ and $\sigma = 2.49$. These findings indicate a less severe outcome of the impact of agro-investment on small farm business entrepreneurs on market participation. According to [Thompson \(2009\)](#) the participation of small farm entrepreneurs in variety of farming activities including markets

require cognitive abilities that encapsulate the level of education, farming experience, business knowledge, socio-economics changes and developments, and institutional support. Small farm business entrepreneurs tend to only have access to local markets in a form spaza and tuck shops and well selling directly to consumers. Agro-investment becomes sacrosanct in enabling market participation in the high value chain of retail, contract, agro-processing markets where the quality of the product defines set standards. In developing countries like South Africa, agricultural output markets are often monopolized by commercial intermediaries with high investment opportunities (Sexton 2009). Empirical studies emphasize that primary level farmers should consider collective marketing in an attempt to overcome structural barriers in volatile markets (Bijman and Ton 2007).

The findings from the study also indicate that potential economic benefits had a $\bar{X} = 7.65$ and $\sigma = 2.48$, which imply less severity of impact. Many scholars are in consensus that entrepreneurship is an integral pillar of stimulating economic growth and development (Zhu et al. 2022). Agricultural investment in innovative entrepreneurship can promote new technologies and practices as an economic benefit that can enhance farm productivity and efficiency, prompting increased yields and profits (Kharga et al. 2021).

A less severe outcome with an aggregate of $\bar{X} = 7.58$ and $\sigma = 2.49$ was recorded in relation to government interventions. The government has the responsibility of enabling a conducive environment for investors to invest and thrive, thereby creating a policy framework, provision of grant funding, provision of training and skills, enabling stakeholder linkages, and addressing environmental issues. The findings of this study indicate that the impact of agro-investment on small farm business entrepreneurs in the fourth industrial revolution in relation to government interventions is minimal. According to Vorley et al. (2012), a clear policy direction is crucial in the creation of investment opportunities and market participation share for small and emerging farmers. The implementation of South African policies aimed at bridging the gap between small farm entrepreneurs and the commercial agricultural sector remains slow. Findings from the Department of Forestry and Fisheries (DAFF) indicate that government interventions have given rise to the numbers of small farm entrepreneurs producing for sale from 43% and 73% in 2011 and 2018, respectively (DePamphilis 2019).

5. Conclusions, Recommendations, and Research Directions

This study assessed agro-investments in small farm business entrepreneurs in the era of the fourth industrial revolution using Mpumalanga province as the case study. The results from the binary logistic regression empirical analysis revealed that gender, education level, farm size, farming skills and knowledge, farm productivity, and investment opportunities were significant and positively influenced the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. There is a necessity for continuous and deliberate investment in education and training, theory and practice, and land access to stimulate and improve the perception of small farm business entrepreneurs on agro-investment in the fourth industrial revolution. The fourth industrial revolution is characterized by high technological innovation and thus requires high capital injection, especially among small farm business entrepreneurs, who are mainly poor. Investment in agricultural enterprises and empowering farm business entrepreneurs is significant for economic growth, poverty alleviation, food security, and job creation. The study's limitations acknowledge firstly that there is no homogeneous and universal scientific etiquette in academia for determining agro-investment among small farm business entrepreneurs during the fourth industrial revolution. Secondly, budgetary and time constraints limited the overall predetermined sample size from being realized.

Moreover, the findings extrapolated the impact factors of agro-investment on small farm businesses in the fourth industrial revolution as sources of investment, technology, marketing participation, economic benefits, and government interventions. The study emphasizes the need for a broader understanding of the key factors that impact agro-investment among small farm business entrepreneurs and further promotes feasible mea-

asures for effective investments and entrepreneurship development. The study identifies the need for capital investment, inclusive policy framework, business support, technical skills development, and access to markets as crucial aspects in promulgating agro-investment among small farm business entrepreneurs. The concluding summary emphasizes the urgent need for concerted efforts and collaboration between the government, private sector, and civil society groups to assist small farm business entrepreneurs to access microfinance and agricultural business incubation support to improve perception and to offer a broader contextual understanding of the impact of agro-investment in the fourth industrial revolution as a transformative and innovative measure for improved agricultural productivity.

Stemming from the conclusion, the following policy recommendations are thus constructed: the South African government at all levels should be coerced to create enabling environments that will allow and promote agricultural investment activities, especially among small farm business entrepreneurs, thereby providing grant funding, training, and enabling public-private stakeholder linkages. Furthermore, through public-private partnerships, small farm business entrepreneur programs aimed at creating and raising awareness of the fourth industrial revolution and investments should be promoted. A comprehensive understanding of agro-investment and technological innovations can improve the perception and positively impact agricultural production in small farm business enterprises. There is a need for financial policy shifts in agriculture to enable small farm business entrepreneurs to get access to credit, as the lack or inadequate access thereof results in the slow adoption of new technologies. Research into the opportunities and constraints of agro-investment for small farm business entrepreneurs is sacrosanct for consideration in future research. In addition, future studies should also consider comparing the results deduced from this study conducted in Mpumalanga with other provinces in South Africa for a complementary and contradictory outcome to develop and adopt an all-encompassing and applicable agro-investment approach for small farm business entrepreneurs in the fourth industrial revolution.

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References

- Afifi, Abdelmonem, Susanne May, and Virginia A. Clark. 2004. *Computer-Aided Multivariate Analysis*, 4th ed. London: Chapman & Hall, p. 489.
- Agholor, Azikiwe I. 2014. Analysis of Decision Making in Smallholder Irrigation Practice in Shiloh and Zanyokwe Irrigation Schemes in Central Eastern Cape, South Africa. Ph.D. thesis, University of Fort Hare, Alice, South Africa.

- Agholor, Azikiwe I., Oluwasogo D. Olorunfemi, and Kanayo Ogujiuba. 2023. Socio-demographic context of resilience for adaptation to climate change and implication for agricultural extension in Buffelspruit in South Africa. *South African Journal of Agricultural Extension* 51: 4. [CrossRef]
- Agyekumhene, Christopher, Annemarie van Paassen, Phil McNaughten, Marc Schut, and Arnold Bregt. 2018. The Role of ICTs in improving smallholder maize farming livelihoods: The mediation of trust in value chain financing. Paper presented at the 13th European International Farming System Association Symposium, Theme 4-Smart Technologies in Farming and Food Systems, Chania, Greece, July 1–5.
- Ahmad, Nadim, and Richard G. Seymour. 2008. *Defining Entrepreneurial Activity: Definitions Supporting Frameworks for Data Collection*. OECD Statistics Working Paper, no 2008/01. Paris: OECD.
- Allen, Robert C. 2009. *The British Industrial Revolution in Global Perspective: New Approaches to Economic and Social History*. Cambridge: Cambridge University Press.
- Atkeson, Andrew, and Patrick J. Kehoe. 2001. *The Transition to a New Economy after the Second Industrial Revolution*. Working Paper No. 606. Minneapolis: Federal Reserve Bank of Minneapolis, Research Department.
- Atsriku, Gloria E. 2020. *The Adoption of Agriculture Technology in Small-Scale Farming in the Adumasa Community in Ghana*. The Hague: International Institute of Social Studies.
- Baiyegunhi, Lloyd J., and Garin C. Fraser. 2014. Smallholder farmers' access to credit in the Amathole District Municipality, Eastern Cape Province, South Africa. *Jarts* 115: 2.
- Bastiaens, Ida. 2016. Investing in agriculture: A preference for democracy or dictatorship. *The British Journal of Politics and International Relations* 18: 10–11.
- Bauernschuster, Stefan, Oliver Flack, and Stephan Heblich. 2010. Social capital access and entrepreneurship. *Journal of Economic Behaviour and Organization* 76: 821–33. [CrossRef]
- Becker, Gary S. 1964. *Human Capital*. New York: Columbia University Press.
- Berger, Dale E. 2017. *Introduction to Binary Logistic Regression and Propensity Score, Analysis, Statistics Class Supplements*. Claremont: Claremont University.
- Bijman, Jos, and Giel Ton. 2007. *Empowering Smallholder Farmers in Markets: National and International Policy Contexts*. IFAP. AGRI-NATURA Wageningen University and Research. Wageningen: Wageningen University and Research.
- Campbell, Steve, Melanie Greenwood, Sarah Prior, Toniele Shearer, Kerrie Walkem, Sarah Young, Danielle Bywaters, and Kim Walker. 2020. Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing* 25: 652–61. [CrossRef]
- Caswell, Margriet, Keith Fugli, Cassandra Ingram, Sharon Jans, and Cathrine Kascak. 2001. *Adoption of Agricultural Production Practices-Lessons Learned from the United States Department of Agriculture Area Studies Project*; Agricultural Economic Reports. Washington, DC: Resource Economics Division, United States Department of Agriculture 792.
- Chen, Songjiao, William Wilson, Ryan Larsen, and Bruce Dahl. 2014. Investing in agriculture as an asset class agribusiness. *Agribusiness* 31: 353–71. [CrossRef]
- Creswell, John. 2014. *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. Thousand Oaks: Sage.
- DAFF. 2015. *Agricultural Policy Action Plan*; Pretoria: DAFF.
- DARDLEA. 2020. Annual Report. Available online: <https://dardlea.mpg.gov.za> (accessed on 23 March 2022).
- Davies, Fred, Richard P. Bagozzi, and Paul R. Warshaw. 1989. User acceptance of computer technology: A comparison of two theoretical models. *Management Science* 35: 982–1003. [CrossRef]
- DePamphilis, Donald. 2019. *Mergers, Acquisition, and Other Restructuring Activities*. London: Elsevier.
- Dillman, Don A., Jolene D. Smyth, and Leah M. Christian. 2014. *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. Hoboken: John Wiley & Sons.
- Dombrowski, Uwe, and Tobias Wagner. 2014. Mental strain as field of action in the 4IR. *Procedia Cirp* 17: 100–5. [CrossRef]
- Easton, Mark, Geraldine Carrodus, Tim Delaney, Bernie Howitt, Richard Smith, Helen Butler, and Kate McArthur. 2014. *Oxford Big Ideas Geography. History 9: Australian Curriculum*. Oxford: Oxford University Press.
- EIP-Agri. 2017. Shaping the Digital Revolution in Agriculture. Available online: <https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/eip-> (accessed on 23 June 2023).
- European Commission. 2015. *The Platforms for Connected Factories of the Future*. Brussels: European Commission.
- Fan, Jing, Pengzhu Zhang, and David Yen. 2014. G2G information sharing among government agencies. *Information and Management* 51: 120–12. [CrossRef]
- FAO. 2001. *Agricultural Investment and Productivity in Developing Countries*. Economic and Social Development Paper 0259-2460. FAO economic and social development paper, 0259-2460, 148. Rome: FAO.
- FAO. 2013. *The High Level Panel of Experts on Food Security and Nutrition*. Extract from the Report Investing in Smallholder Agriculture for Food Security Summary and Recommendations. Rome: FAO. Available online: <https://www.fao.org/docrep/018/i2953e/i2953e.pdf> (accessed on 23 October 2023).
- FAO. 2018. *Smallholders and Family Farmers*. Available online: <https://www.fao.org/docrep/018/ar588e/ar588e.pdf> (accessed on 27 November 2023).
- Fowler, Floyd J. 2017. *Survey Research Methods*, 5th ed. New York: SAGE Publications.
- Foxcroft, Mary-Lyn, Eric Wood, Jacqui Kew, Mike Herrington, and Nick Segal. 2002. Global Entrepreneurship Monitor South African Report. Available online: <https://ssrn.com/abstract=1509253> (accessed on 26 July 2023).

- Furuholt, Bjorn, and Edmund Matotay. 2011. The developmental contribution from mobile phones across the agricultural value chain in rural Africa. *The Electronic Journal of Information Systems in Developing Countries* 48: 1–16. [CrossRef]
- Ghiasy, Fereshteh G., and Jamal Hosseini. 2012. Studying the variables that separate entrepreneurial and non-entrepreneurial agricultural producer cooperatives for predicting group membership. *African Journal of Agricultural Research* 7: 721–25.
- Glover, Dominic, James Sumberg, Giel Ton, and Jens Andersson. 2019. Rethinking technological change in smallholder agriculture. *Outlook on Agriculture* 48. [CrossRef]
- Gnyawali, Devi. R., and Dan S. Fogel. 1994. Environments for entrepreneurship development: Key dimensions and research implications. *Entrepreneurship Theory and Practice* 18: 43–62. [CrossRef]
- Goldstein, Markus, and Christopher Udry. 2008. The profits of power: Land rights and agricultural investment in Ghana. *Journal of Political Economy* 116: 981–1022. [CrossRef]
- Görg, Holger, Oliver Morrissey, and Manop Udomkerdmongkol. 2007. *Investment and Sources of Investment Finance in Developing Countries*. GEP Discussion Papers. Nottingham: University of Nottingham.
- Grzelak, Aleksander, and Piotr Kufyk. 2020. Is Michał Kalecki's theory of investment applicable today? The case study of agricultural holdings in the EU countries. *Agricultural Economics* 66: 317–24. [CrossRef]
- Gwebu, Jabulile Z., and Nicolette Matthews. 2018. Meta frontier analysis of commercial and smallholder tomato production: A South African case. *South African Journal of Science* 114: 7–8. [CrossRef]
- Hadebe, Nolwazi. 2016. The Impact of Capital Endowment on Smallholder Farmers' Entrepreneurial Drive in Taking Advantage of Small-Scale Irrigation Schemes: Case Studies from Makhathini and Ndumo B irrigation Schemes in KwaZulu-Natal in South Africa. Master's dissertation, University of KwaZulu-Natal, Durban, South Africa.
- Heeks, Richard. 2018. *Development Implications of Digital Economies*. Manchester: Centre for Development Informatics, University of Manchester.
- Herrington, Mike, and Jacqui Kew. 2013. GEM 2013 South African Report: Twenty Years of Democracy. Available online: https://www.researchgate.net/publication/317566527_GEM_South_Africa_2013_Report (accessed on 7 April 2023).
- Herrington, Mike, Jacqui Kew, and Penny Kew. 2009. *Tracking Entrepreneurship in South Africa: A GEM Perspective*. Cape Town: Graduate School of Business, University of Cape Town.
- Hisrich, Robert D., Michael P. Peters, and Dean A. Shepherd. 2013. *Entrepreneurship*, 9th ed. New York: McGraw-Hill/Irwin.
- Juma, Calestous, and David Spielman. 2014. Farmers as Entrepreneurs: Sources of Agricultural Innovation in Africa. In *New Directions for Smallholder Agriculture*. Oxford: Oxford University Press, pp. 201–10.
- Kalecki, Michal. 1935. A macrodynamic theory of business cycle. *Econometrica* 3: 327–344. [CrossRef]
- Kharga, Basu D., Anindita Saha, K. Pradhan, and Rakesh Roy. 2021. Focusing the relationship of net profit with the determinant attributes of rural entrepreneurs. *Indian Journal of Extension Education* 57: 135–38.
- Koo, Justin. 2014. Improving Yields of Smallholder Farmers: IFPRI. Available online: <https://harvestchoice.org/topics/input-use> (accessed on 19 February 2024).
- Lado, Augustine, and George S. Vozikis. 1996. Transfer of technology to promote entrepreneurship in developing countries: An integration and proposed framework. *Entrepreneurship Theory and Practice* 21: 55–72. [CrossRef]
- Lamsal, Ritu R., P. Karthikeyan, Pablo Otero, and Alfonso Ariza. 2023. Design and Implementation of Internet of Things (IoT) Platform Targeted for Smallholder Farmers: From Nepal Perspective. *Agriculture* 13: 1900. [CrossRef]
- Lee, H. J. 2017. *The Fourth Industrial Revolution and the Future of Agriculture, Smart Farm and Shared Economy*. Sejong-si: Science and Technology Policy Institute.
- Levchuk, L. 2015. Investment of agricultural sector of economy in crisis. *International Journal of New Economics and Social Sciences* 2: 41–48. [CrossRef]
- Li, Suhong, Richard Glass, and Hal Records. 2008. The Influence of Gender on New Technology Adoption and Use—Mobile Commerce. *Journal of Internet Commerce* 7: 270–89. [CrossRef]
- Loftas, T., and FAO. 2021. *Investing in Agricultural Development*. 2006140724. Rome: FAO.
- Lom, Michal, Ondre Pribyl, and Miroslav Svitek. 2016. Industry 4.0 as a Part of Smart Cities. In *Smart Cities Symposium Prague (SCSP)*. pp. 1–6. Available online: <https://translateyar.ir/wp-content/uploads/2020/09/Industry-4.0-as-a-Part-of-Smart-Cities.pdf> (accessed on 29 June 2023).
- Luiz, John, and Martine Mariotti. 2011. Entrepreneurship in an emerging and culturally diverse economy: A South African survey of perceptions. *South African Journal of Economic and Management Sciences* 14: 47–65. [CrossRef]
- Magadla, Anelisiwe. 2023. The Role of Small-Scale Agricultural Business on Youth Employment at a Selected District in the Eastern Cape, South Africa. Master's dissertation, Cape Peninsula University of Technology, Cape Town, South Africa.
- Mamabolo, Anastacia, Myres Kerrin, and Tumo Kele. 2017. Entrepreneurship management skills requirements in an emerging economy: A South African outlook. *The Southern African Journal of Entrepreneurship and Small Business Management* 9: 10. [CrossRef]
- Manasoe, Benjamin, Victor Mmbengwa, and Joseph Lekunze. 2023. Entrepreneurship and economic empowerment of small-scale Agro-processors in South Africa: Implications for Small Business Development and Entrepreneurship Research. In *An Overview on Business*. *Management and Economics Research* 2: 101–37.
- Manda, More I., and Judy Backhouse. 2016. Addressing Trust, Security and Privacy Concerns in E-Government Integration, Interoperability and Information Sharing through Policy: A Case of South Africa. Available online: <http://aisel.aisnet.org/confirm2016/67> (accessed on 12 March 2024).

- Manda, More I., and Soumaya B. Dhaou. 2019. Responding to the challenges and opportunities in the 4th Industrial revolution in developing countries. Paper presented at the 12th International Conference on Theory and Practice of Electronic Governance, Melbourne, Australia, April 3–5.
- Masere, Tirivashe P. 2015. An evaluation of the role of extension in adoption of new technology by small-scale resource-constrained farmers. A case of lower Gweru communal area, Zimbabwe. Ph.D. thesis, University of KwaZulu Natal, Pietermaritzburg, South Africa.
- McKenzie, Shawn. 2007. A Brief History of Agriculture and Food Production: The Rise of Industrial Agriculture. Available online: <https://resources.saylor.org/wwwresources/archived/site/wp-content/uploads/2015/07/ENVS203-7.3.1-ShawnMackenzie-ABriefHistoryOfAgricultureandFoodProduction-CCBYNC-SA.pdf> (accessed on 19 November 2023).
- McKinsey Global Institute. 2015. South Africa's Big Five: Bold Priorities for Inclusive Growth. Available online: <http://www.mckinsey.com/global-themes/middle-east-and-africa/south-africa-s-bold-priorities-for-inclusive-growth> (accessed on 14 February 2024).
- Mercer, Daniel E., Jeremy Haggard, Anne Snook, and Mauricio Sosa. 2005. Agro-forestry adoption in the Calakmul Biosphere Reserve, Campeche, Mexico. *Small-Scale Forest Economics, Management and Policy* 4: 163–84. [CrossRef]
- Metzger, Mariam, and Flanagan Adrew. 2013. Credibility and Trust of Information in Online Environments: The Use of Cognitive Heuristics. *Journal of Pragmatics* 59: 210–20. [CrossRef]
- Mpumalanga Department of Finance. 2015. Public Expenditure and Financial Accountability Assessment. Available online: <http://www.finance.mpu.gov.za> (accessed on 28 August 2023).
- Mtombeni, Siphon, Daniela Bove, and Tankiso Thibane. 2019. An Analysis of Finance as a Barrier to Entry and Expansion for Emerging Farmers. Working Paper CC2019/01. *Statistics*. Available online: <https://www.compcom.co.za/wp-content/uploads/2019/09/CC201901-Mtombeni-S-Bove-D-Thibane-T-An-analysis-of-finance-as-a-barrier-to-entry-for-emerging-farmers.pdf> (accessed on 28 August 2023).
- Nkosi, Mzwakhe. 2022. The Fourth Industrial Revolution's Opportunities and Constraints: A Case of Smallholder Farmers in Breyten and Lothair, Mpumalanga Province in South Africa. Master's dissertation, University of Mpumalanga, Nelspruit, South Africa.
- OECD. 2001. *Adoption of Technologies for Sustainable Farming Systems Wageningen Workshop Proceedings*. Paris: OECD Publishers.
- Ogujiuba, Kanayo. 2021. Determinants of female entrepreneurship success in the agricultural sector: An examination of SMEs in South Africa. *International Journal of Economics and Financial Issues* 11: 123–33.
- Ogujiuba, Kanayo, Ebenezer Olamide, Chinelo Ogujiuba, and Nancy Stiegler. 2021. Effect of Contextual Factors on Entrepreneurship Success in South Africa: Application of Two-Way Analysis of Variance Design. *Academy of Entrepreneurship* 27: 3.
- Oguz, Fatih, and Shimelis G. Assefa. 2014. Faculty members' perceptions towards institutional repository at a Medium-Sized University. *Library Review* 63: 189–202. [CrossRef]
- Otsuka, Keijiro, and Donald F. Larson. 2015. *In Pursuit of an African Green Revolution: Views from Rice and Maize Farmers' Fields*. Dordrecht: Springer.
- Persson, Karl G. 2010. *An Economic History of Europe: Knowledge, Institutions and Growth, 600 to the Present*. New York: Cambridge University Press.
- Rai, Raju, Yili Zhang, Basanta Paudel, Jianzhong Yan, and Narendra R. Khanal. 2023. Analysis of farmers' perceptions of climate change and Adaptation Strategies in the Transboundary Gandaki River Basin. *Land* 12: 2054. [CrossRef]
- Salam, Md A., T. Noguchi, and Masao Moike. 2000. Understanding why farmers plant trees in the homestead Agro-forestry in Bangladesh. *Agroforestry Systems* 50: 77–93. [CrossRef]
- Schwab, Klaus. 2016. *The Fourth Industrial Revolution*. Geneva: World Economic Forum.
- Sexton, M. P. 2009. Optimal investment in transportation infrastructure when middlemen have market power: A developing-country analysis. *American Journal of Agricultural Economics* 91: 462–76.
- Shane, Scott, and Sivakumar Venkataraman. 2000. The promise of entrepreneurship as a field of research. *The Academy of Management Review* 25: 217–26. [CrossRef]
- Stats SA. 2023. Gross Domestic Product: First Quarter. Statistical Release. Available online: <https://www.bea.gov/news/2023/gross-domestic-product-first-quarter-2023-advance-estimate> (accessed on 16 March 2023).
- Statistics South Africa Census. 2022. Population Studies. Available online: www.statssa.gov.za (accessed on 21 August 2023).
- Stukan, Tatyana. 2020. Features of use of informal forms of investment by agricultural enterprises in digital agriculture. *Economics, Management of Sectors and Enterprises* 16: 97–101. [CrossRef]
- Suman, Kalyani K., Tejas G. Murthy, and Rao C. Chandrasekhar. 2014. Innovative approaches for sustainable productivity among tribal families of East Godavari district. *Journal of Agricultural Extension and Rural Development* 6: 5–10. [CrossRef]
- Swinnen, Johan. 2018. Public investments in agricultural and food research. *The Political Economy of Agricultural and Food Policies* 10: 189–97.
- Tanzi, Yongama. 2020. Analysis of Investment Opportunities Available to Small Businesses and Investment Clubs in Gauteng Province. Master's dissertation, Wits University, Johannesburg, South Africa.
- Thompson, Edmund. 2009. Individual entrepreneurial intent: Construct Clarification of an Internationally Reliable Metric. *Entrepreneurial Theory and Practice Journal* 33: 669–94. [CrossRef]
- Vink, Nick, and Johann Kirsten. 2003. Agriculture in the national economy. In *The Challenge of Change: Agriculture, Land and the South African Economy*. Pietermaritzburg: University of Natal Press.

- Vorley, William, Lorenzo Cotula, and Man-Kwun Chan. 2012. Tipping the balance: Policies to shape agricultural investments and markets in favour of small-scale farmers. *Oxfam Policy and Practice: Private Sector* 9: 59–146.
- WEF. 2016. *The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution*. Geneva: World Economic Forum.
- WEF. 2018a. *Agile Governance. Reimagining Policymaking in the Fourth Industrial Revolution*. Working Paper. Geneva: World Economic Forum.
- WEF. 2018b. *Shaping the Future of Global Food Systems: A Scenarios Analysis*. Geneva: World Economic Forum.
- World Bank. 2019. *World Development Report: The Changing Nature of Work*. Geneva: World Bank.
- Xie, Lin, Biliang Luo, and Wenjing Zhong. 2021. How Are Smallholder Farmers Involved in Digital Agriculture in Developing Countries: A Case Study from China. *Land* 10: 245. [[CrossRef](#)]
- Yusupjonovich, D. 2019. Effective use of investment in agriculture of the republic of Uzbekistan. *Asian Journal of Multidimensional Research* 8: 6. [[CrossRef](#)]
- Zhu, Lei, Chenyujing Yang, Yuanyuan Zhang, and Yongji Xue. 2022. Using marginal land resources to solve the shortage of rural entrepreneurial land in China. *Land* 11: 1035. [[CrossRef](#)]

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